METEOROLOGICAL OFFICE
5 - FEB 1929
KINGSTON, RAMSGATE, KENT

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M.O. 232b.

METEOROLOGICAL OFFICE, LONDON.

PROFESSIONAL NOTES NO. 2.

NOTES ON EXAMPLES OF KATABATIC WIND IN THE VALLEY OF THE UPPER THAMES AT THE AEROLOGICAL OBSERVATORY OF THE METEOROLOGICAL OFFICE AT BENSON, OXON.,

BY

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Published by the Authority of the Meteorological Committee.

LONDON:
To be purchased from
THE METEOROLOGICAL OFFICE, Exhibition Road, London, S.W.7.

1918.

Price 3*d. Net.*

NOTES ON EXAMPLES OF KATABATIC WIND IN THE VALLEY OF THE UPPER THAMES AT THE AEROLOGICAL OBSERVATORY OF THE METEOROLOGICAL OFFICE AT BENSON, OXON.

In settled fine weather at Benson the normal decrease of the velocity of the wind at night is often checked soon after six o'clock in the evening, when a steady breeze sets in from between E. and E.S.E., in which direction lies the main range of the Chiltern Hills. The Observatory is on level ground, which soon begins to ascend towards the south-east, and rises gradually for two or three miles to the foot of the downs. The highest parts of these downs are about 800 feet above the level of the sea and 600 feet above the Observatory. The head of the pressure-tube anemometer, whose records have been consulted when studying this night breeze, is 84 feet above the ground.

There are two complete years available for study, namely, 1915 and 1916.

When selecting suitable illustrations, it was not found possible to lay down any strict rule for deciding whether any particular night should be included or not, but experience had already shown that when an easterly wind arose at night in clear weather, it generally did so between 18 hours and 22 hours and blew very steadily from E. by S. or E.S.E., regardless of what the direction had been during the previous day. Although the velocity might exceed that reached at any time during the day, the range of gusts was generally much smaller. All nights that did not satisfy these conditions were rejected, and there remained nine excellent examples of the type of wind in question, six of which are shown in Figures I. and II. So remarkable is the similarity between these nine cases that one is embarrassed in deciding which to describe as the ideal type, but, after some hesitation, I have selected the beautifully regular rise and fall of the wind on the night of April 29th, 1915. There are some cases which show the absence of gusts more clearly, and others in which the shifting of the wind to E.S.E. is more sudden, but in no case is the general effect more arresting than in the present instance. On this day a large anticyclone was centred over the British Isles, giving rise to quiet weather and clear skies. The anemometer trace during the day is of the type usual under these conditions, and shows a gradual increase of the light wind up to about noon, when the highest gust of the day was registered, and then a gradual decrease towards the evening. The direction varied between N.E. and S.E. during the day, and was due east at 19 hours. Shortly before 20 hours a shift of the direction to a point betweeen E. by S. and E.S.E., and a jerky rise of the

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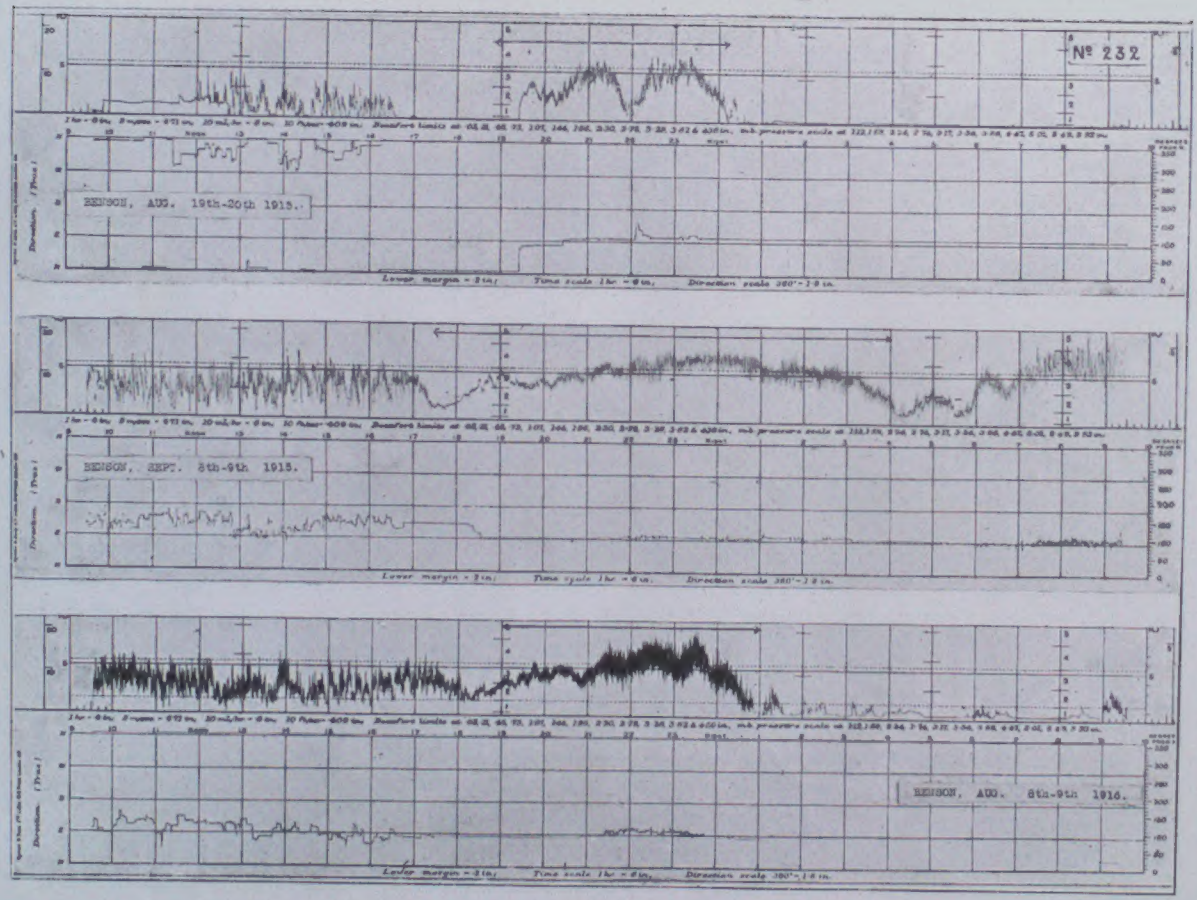
Anemograms for three cases of valley wind at night. The arrows above the records of velocity indicate the duration of the special type of wind.



August 19th–20th, 1915.

September 8th–9th, 1915.

August 8th–9th, 1916.

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FIG. I.

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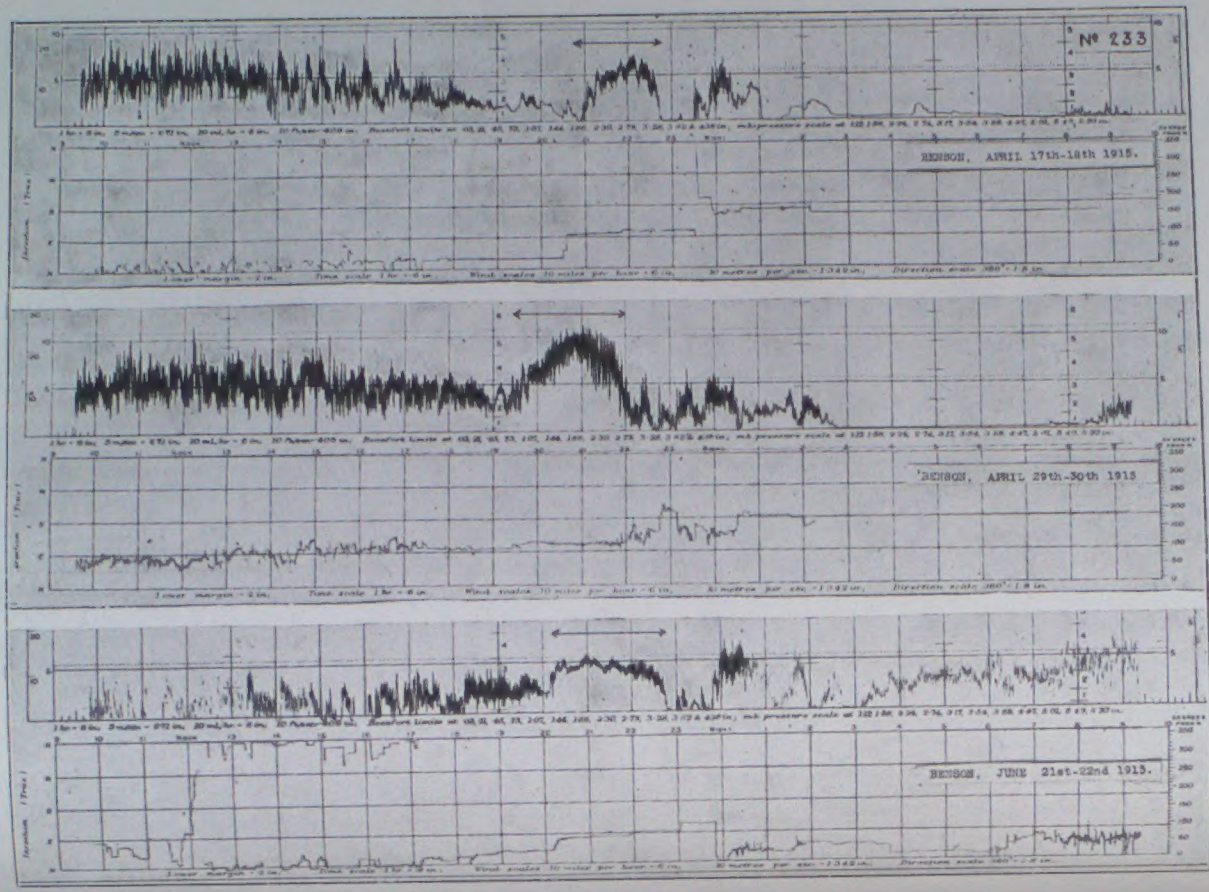
Anemograms for three cases of valley wind at night. The arrows above the records of velocity indicate the duration of the special type of wind.



April 17th–18th. 1915.

April 29th–30th, 1915.

June 21st–22nd, 1915.

Fig. 11.

velocity, announced the beginning of the night wind, which blew with the force of a fresh breeze for just two hours and then turned into a light gusty breeze of variable direction, which died out shortly before three o'clock in the morning. The velocity of 9 metres per second attained at 21 hours is the highest so far recorded under these conditions, and is somewhat remarkable in the centre of an anticyclone, at a time when the map indicated no gradient of pressure over the south-east of England.

Each of the nine anemograms have their individual peculiarities, but they differ so little that it seems worth while to work out hourly means of the wind velocity and also corresponding values of the gustiness and temperature. The gustiness was obtained by dividing the difference between the maximum gust and the maximum lull for an interval of 10 minutes by the mean velocity during that time. The results are given in Table I. and are plotted in Figure III.

TABLE I.

——	h. 10	h. 11	h. 12	h. 13	h. 14	h. 15	h. 16	h. 17	h. 18	h. m. 18.30	h. 19	h. m. 19.30	h. 20	h. m. 20.30	h. 21
Wind Velocity...	3·2	3·2	3·4	3·4	3·2	3·2	3·1	2·9	2·5	2·7	3·0	3·5	4·1	4·4	4·7
Temperature ...	61·3	63·2	64·9	66·2	67·0	67·1	67·0	66·6	64·1	—	59·9	—	56·6	—	54·4
Gustiness ...	1·2	1·8	1·7	1·4	1·6	1·6	1·3	1·0	0·9	—	0·8	—	0·5	—	0·6

——	h. m. 21.30	h. 22	h. m. 22.30	h. 23	h. m. 23.30	h. 24	h. m. 24.30	h. 1	h. 2	h. 3	h. 4	h. 5	h. 6	h. 7
Wind Velocity...	4·6	4·3	3·6	3·2	3·1	3·0	2·6	1·7	1·5	1·0	0·9	1·0	1·0	1·3
Temperature ...	—	53·7	—	52·8	—	51·2	—	49·4	47·6	46·0	44·5	44·2	45·8	50·7
Gustiness ...	—	0·7	—	0·8	—	1·2	—	0·8	0·7	(0·5)	(1·0)	(0·8)	(1·0)	(1·2)

(The values of gustiness in brackets are based on two observations only.)

TABLE I.

——	h. 10	h. 11	h. 12	h. 13	h. 14	h. 15	h. 16	h. 17	h. 18	h. m. 18.30	h. 19	h. m. 19.30	h. 20	h. m. 20.30	h. 21
Wind Velocity...	3·2	3·2	3·4	3·4	3·2	3·2	3·1	2·9	2·5	2·7	3·0	3·5	4·1	4·4	4·7
Temperature ...	61·3	63·2	64·9	66·2	67·0	67·1	67·0	66·6	64·1	—	59·9	—	56·6	—	54·4
Gustiness ...	1·2	1·8	1·7	1·4	1·6	1·6	1·3	1·0	0·9	—	0·8	—	0·5	—	0·6

——	h. m. 21.30	h. 22	h. m. 22.30	h. 23	h. m. 23.30	h. 24	h. m. 24.30	h. 1	h. 2	h. 3	h. 4	h. 5	h. 6	h. 7
Wind Velocity...	4·6	4·3	3·6	3·2	3·1	3·0	2·6	1·7	1·5	1·0	0·9	1·0	1·0	1·3
Temperature ...	—	53·7	—	52·8	—	51·2	—	49·4	47·6	46·0	44·5	44·2	45·8	50·7
Gustiness ...	—	0·7	—	0·8	—	1·2	—	0·8	0·7	(0·5)	(1·0)	(0·8)	(1·0)	(1·2)

(The values of gustiness in brackets are based on two observations only.)

Figure III. *To face p. 16.*

DIAGRAM SHOWING HOURLY MEANS OF WIND VELOCITY, GUSTINESS AND TEMPERATURE AT BENSON, OBTAINED FROM NINE CASES OF VALLEY WIND AT NIGHT.

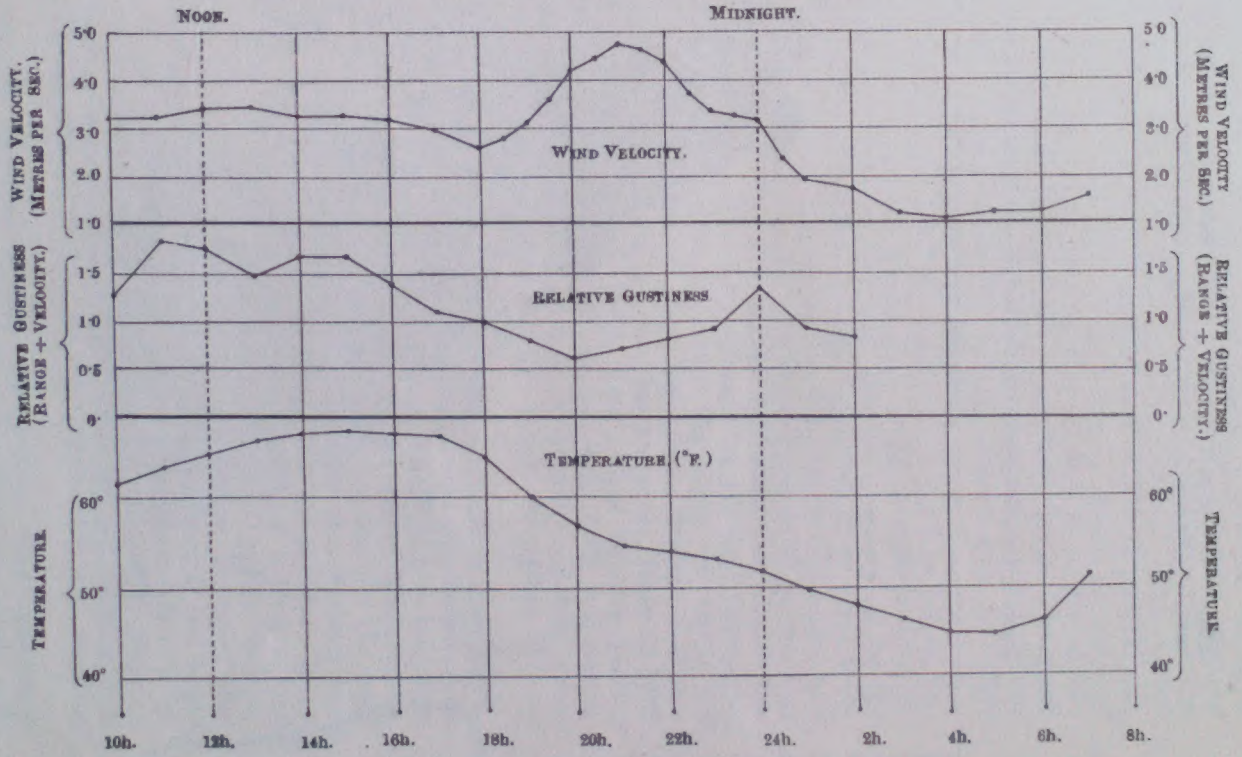


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Figure IV.

To face p. 17.

MAP SHOWING THE POSITION OF BENSON WITH REGARD TO THE CHILTERN HILLS.

The arrow is depicted flying with the nocturnal breeze which blows from E. by S.

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The curves bring out the salient features very clearly, and the resemblance between the mean velocity curve and that for April 29th, 1915, already described, is remarkably close. The evening wind quite masks the normal diurnal range between 18 hours and midnight, which is otherwise clearly shown. The normal curve for temperature near to the ground is also interfered with during this period, but this is more clearly shown on some of the individual thermograms, and may amount to a rise of two degrees, as happened on April 17th and 29th, 1915. The gustiness is seen to be much less at 21 hours than at noon. In Table II. particulars of the weather on the nine selected days and other details of interest are collected together.

The limits of the six summer months from April to September, on occasions when a clear sky is united with a uniform distribution of pressure over the south of England, appear to be the conditions under which this phenomenon arises in its ideal form. The diurnal range of temperature is then unusually large, and the figures found are seen to vary from eighteen to as much as thirty-four degrees. Examining each individual case, it was seen that the night which had been selected as the best example—namely, April 29th, 1915—was also the night on which the greatest fall of temperature was experienced; further, that two other occasions when the range was thirty degrees, those of June 21st, 1915, and April 2nd, 1916, were almost equally perfect examples, whereas the night of August 8th, 1916, had nearly been rejected altogether on account of its comparatively gusty character, and on this occasion the range amounted to only eighteen degrees.

The facts all tend to show that this wind must be classified as what is known as a valley wind, or, more recently, a katabatic wind, representing the downward flow of air cooled by radiation on the slopes of the hills. At Mr. W. H. Dines' observatory, at Pyrton Hill, which was a few miles further east on the same side of the Chilterns, but actually at the very foot of the higher downs, a well-marked valley wind had been recognised,* and it is interesting to find that on suitable occasions it may extend to a distance of several miles across the more gently inclined surface of the country. The contour map shows, however, that from the Observatory right up to the higher portion of the downs the lie of the land is such as to convert a downward flow of air into a steady breeze from E. by S., and on the solitary occasion when the direction of the nocturnal breeze differed slightly from this direction the recording pen was evidently not working freely.

The rise of temperature near the ground that sometimes accompanies the breeze may readily be explained, for on still, clear nights such as these the potential temperature increases rapidly in a vertical direction on leaving the ground, and any stirring up of the air must inevitably raise the temperature of the lowest layer. It should be noted that it is the difference of

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* J. S. Dines. Fourth Report on Wind Structure to the Advisory Committee for Aeronautics.

temperature between the air near to the ground on the slopes of the hills and the free air at the same level that is the first cause of a valley wind and that it matters very little what the temperature may be at the bottom of the valley.

It is not easy to explain why the night breeze does not appear on every summer evening when the sky is clear and there is no gradient of pressure shown upon the map. In the two months of April and May, 1915, when much clear weather was experienced, there were two occasions when the gradient wind at 21 hours appeared to be zero and the sky was reported clear at 3 hours next morning, and two when it did not exceed 5 metres per second, the fall of temperature on these occasions ranging from 23° to 26°, but in none of these cases did any breeze from E. by S. make its appearance, although the light northerly winds that had been blowing during the day quite died out during the early part of the night. It is, therefore, not possible to predict the occurrence of this phenomenon at a specified station with complete certainty.

3rd March, 1917.

TABLE II.

Date.	Details of Night Breeze.			Diurnal Fall of Temp.	Pressure Conditions.				Sky at 1h. or 3h.	Wind during Day.	
	Time of Rise.	Time of Fall.	Direction.		——	Gradient Wind.					
						18h.	21h.	1h. or 3h.		Direction.	Force.
1915.	h. m.	h. m.		°							
April 17 ...	21 0	22 40	E by S	22	Anticyclonic. Highest to S.W.	0	0	0	b	NNW–NE	2–4
„ 29 ...	19 45	22 0	E by S	34	Centre of Anticyclone	0	0	0	b	NE–SE	3–4
June 21 ...	20 15	22 45	E by N	30	Irregular	*E (slight)	E_5	ESE_9	b	NW–NE	1–2
August 19 ...	19 30	24 15	E by S	25	Anticyclone W. of Ireland ...	0	0	0	b	W-N	1–2
Sept. 8 ...	18 0	4 0	E by S	20	Anticyclone over N. Sea and Norway.	SE_7	SSE_8	SSE_9	b	E–SE	2–3
1916.											
April 2 ...	18 0	21 10	E by S	30	Anticyclonic ridge	0	0	0	b	ENE–ESE	3–4
May 18 ...	18 0	24 0	E by S	25	Anticyclone over N. Sea ...	E (slight)	0	0	b	Variable	1–2
July 20 ...	19 0	22 0	E by S	24	Centre of Anticyclone	0	0	0	b	NNE–NW	1–3
August 8 ...	18 45	24 30	E by S	18	Near Centre of Anticyclone ...	S.E. (slight)			b	SE–NE	2–3